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INFLATION, GOVERNMENT DEFICITS AND PRIVATE SAVING

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ABSTRACT

This paper analyzes the way in which government deficits and inflation influence private saving. The analysis focuses on two specific issues: the extent to which future taxes called for by government deficits are reflected in the decision to save, and the ability of consumers to distinguish their real income from that measured by national income accountants. Implications for these issues are derived in the context of the life cycle hypothesis, and tested over an international cross section of observations on aggregate saving spanning the period 1960 to 1979. The results indicate that while consumers are able to correctly distinguish their true from their reported income, they do not appear to recognize the future taxes associated with government deficits. The estimates also show that the upwards shift in the private savings ratio observed between the sixties and the seventies is not completely explained by the model analyzed here.

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I. INTRODUCTION

In this I paper analyze the way in which government deficits and inflation influence private saving. The analysis focuses on two specific issues: the extent to which future taxes called for by government deficits are reflected in the decision to save, and the ability of consumers to distinguish their real income from that measured by national income accountants.

Government deficits influence saving through the life cycle budget constraint and the time pattern of disposable income received by the individual. In the life cycle model consumption depends on life cycle wealth, and saving on the difference between the rate of consumption and the flow of income. To the extent that government deficits simply transfer income from one period to the next without changing life cycle wealth they should have no affect on consumption, influencing only the pattern of saving. In the limit as government deficits represent pure intertemporal transfers, private saving should increase dollar for dollar with increased deficits.

While inflation may have many effects on private saving, I focus upon the bias it introduces in the measurement of income and saving in the national income accounts. As shown below, this channel through which inflation may affect measured saving has specific testable characteristics. Furthermore, it is shown that this effect of

inflation interacts with the way in which government deficits influence saving. This is because both current real government debt and future real taxes required to pay off that debt are reduced by inflation.

The way in which government deficits and inflation enter in a simple life cycle model of the determination of the private savings ratio is presented in section II. Estimation strategy and difficulties as well as the data used in the study are discussed in section III. Empirical results are given in section IV, and conclusions in section V.

II. Government Deficits and Inflation in the Life Cycle Model

In this section I show how government deficits and inflation may influence the private savings ratio. In order to focus on the way in which these variables influence private saving, I take as given a function $s^*(\ )$, which describes how variables other than deficits and inflation influence private saving. The precise specification of $s^*(\ )$ is discussed below. In the absence of inflation and government deficits, true private saving, S^*, is given by:

$$(1) \qquad S^* = s^*(\ )Y^*,$$

where Y^* is true income. The distinction between true and reported saving and income has to do with the way in which inflation influences the measurement of those variables; it is defined precisely below.

1. Government Deficits

Under the Life Cycle Hypothesis (LCH) people are assumed to maximize utility subject to a lifetime budget constraint. Saving or dissaving occurs to maintain consumption at a level reflecting life cycle wealth rather than current income. An important implication of the LCH is that consumption should be independent of transfers which leave life cycle wealth unchanged.

Government deficits appear to be one such intertemporal transfer scheme. By issuing debt, the government borrows against the future, and it must generally repay its debts. Thus, under the LCH, if private consumption plans are initially optimal, recipients of the proceeds of the governments borrowing will not change their consumption. Instead, they will increase their saving by the present value of the additional taxes they expect to face when the debt is repaid. As long as the government deficit does not transfer wealth to or from those alive at the time of the deficit, and people discount future taxes at the rate of interest on the debt, the present value of the taxes must equal the amount of the deficit.

The fact that government deficits generate future taxes and so may not increase private wealth was recognized by Patinkin [1965, pp. 288-294].(1) He assumed that a fraction of the debt was in fact treated as wealth by its holders. The present value of the requisite future taxes may be less than the value of the government deficit if future taxes are shifted to future generations. If, for example, the transfer is received solely by retired people and the taxes are paid solely by income taxes on wages, such a shift may be obtained.

Recently, however, Barro [1974] has shown that the current generation may correctly discount all future taxes, including those levied solely on their descendants. His result depends on intergenerational utility of the appropriate form, an unbroken chain of descendants and the absence of constraints on bequests. While the relevance of Barro's analysis has been challenged by, among others, Feldstein [1976], Drazen [1978], Buiter [1979], Buiter and Tobin [1979], Tobin [1980] and Tobin and Buiter [1980], it remains an important proposition.

The above discussion suggests that if people do in fact treat government deficits as intertemporal transfers, the deficits should induce offsetting private saving. Furthermore, the reaction to pure intertemporal transfers is independent of the underlying forces of growth and tastes which determine the private savings rate. This suggests that adding a term of the form $\delta * D^*$ to the right hand side of(1) is appropriate, where D^* is the true government deficit, and δ a coefficient. The LCH without Barro's bequest motive suggests

that δ must lie between zero and one. Barro's analysis suggests that δ should be unity regardless of the government's attempts at intergenerational tax shifting. Rewriting (1) to take the effect of deficits into account, true saving should be given by:

$$(2) \qquad S^* = (s^*(\ ) + \delta D^*/Y^*)Y^*.$$

It should be emphasized that government deficits may not induce offsetting saving if they are something other than simple intertemporal transfer schemes. If deficits finance government consumption rather that transfer programs, and if government consumption is not a perfect substitute for private consumption, deficits would not influence savings in the manner discussed above.

3. Anticipated Inflation and Measured versus True Income

In the presence of inflation firms and households holding nominal assets persistently lose a fraction of their real wealth to inflation. To the extent that it is anticipated, this loss is offset by a rise in nominal interest rates to incorporate expected inflation. While the increased nominal interest payments are counted as income in the national income accounts, no entry is made for the anticipated loss in value of nominal assets. Though the loss does appear as a reconciliation entry in national balance sheets, the anticipated component is more appropriately considered a component of income, in just the same manner as nominal interest. In this

interpretation, measured income is overstated by the amount of the anticipated capital losses or, equivalently, by the component of interest income due solely to anticipated inflation. Measured saving may also be overstated, since no account is made for the capital losses suffered by the holders of nominal assets. (Reasons why saving may not be overstated are discussed below.)

Several authors have estimated the magnitude of the capital losses. Their estimates suggest the bias may be large; for the United States Siegal [1979] estimates the true private saving rate to have been 200 basis points lower than the reported rate in the postwar period, while Jump [1980] estimates the average difference to be 150 basis ponts for the personal saving rate. Calculations for Italy by Cotula and Masera [1980] suggest that the difference could be as much as 1000 basis points in the seventies. Results for several OECD countries (not including Italy) reported by Blades and Sturm [1982] indicate an average difference of roughly 350 basis points. In this section I show how the mismeasurment effect can be explicitly incorporated into the analysis of saving rates.

I assume that people estimate their true income and saving by subtracting a fraction of their expected capital losses from their reported income, Y, (which includes the full amount of nominal interest income) and reported saving, S. Their expected capital losses are $\pi^e G$, where π^e is the anticipated rate of inflation and G the nominal value of government debt held by the private sector. If λ is the fraction of the loss subtracted from reported income and

saving, individuals perceive their true income and saving to be:

$$Y^* = Y - \lambda\pi^e G$$

$$S^* = S - \lambda\pi^e G$$

Substituting these expressions for Y^* and S^* in (2) yields:

$$(3) \qquad S - \lambda\pi^e G = (s^*(\ ) + \delta D^*/Y^*)(Y - \lambda\pi^e G).$$

The measured savings rate, $s = S/Y$, is then given by:

$$(4) \qquad s = (s^*(\ ) + \delta D^*/Y^*)(1 - \lambda\pi^e G/Y) + \lambda\pi^e G/Y.$$

It is useful to express the deficit to income ratio in measured rather than true terms. Defining the true deficit to be $D^* = D - \lambda\pi^e G$, substituting into (4) and combining like terms yields:

$$(5) \qquad s = s^*(1 - \lambda\pi^e G/Y) + \delta D/Y + \lambda(1 - \delta)\pi^e G/Y.$$

It can be seen from (5) that the private saving ratio will rise or fall with anticipated inflation to the extent that government debt is regarded as net wealth. If debt holders completely disregard future

taxes ($\delta = 0$), their real wealth can be maintained in the face of inflation only by increasing saving by the full amount of the increased nominal interest payments. Since equal increments are added to both savings and income the measured savings ratio rises. If, on the other hand, the future tax liabilities associated with the government debt are completely capitalized ($\delta = 1$), the measured savings rate will tend to fall with anticipated inflation. In this case inflation reduces both the value of the debt and the value of future tax liabilities; the individual's net wealth is thus unaffected, and no increase in to private saving is called for.

4. Other Effects of Inflation

Equation (5) describes the impact of neutral, anticipated inflation on the private savings rate. What happens if inflation is not neutral, or if it is unanticipated?

Non-neutral inflation has no effect on the savings rate as long as i) its non-neutralities do not affect the function $s^*(\ )$, and ii) they are permanent. The nature of the function $s^*(\ )$ is discussed in more detail below; essentially, however, it reflects growth in real income. As pointed out by Fischer and Modigliani [1979], inflation is likely to have many real effects, some of which may influence the rate of growth of income. Among them are factors which tend to both favor capital formation (as an alternative to holding money), inhibit capital formation (due to the taxation of purely nominal gains; see Feldstein [1982], Feldstein and Summers [1978] and Summers [1981] for

analysis) and affect the supply of labor (through progressive taxation of nominal rather than real income). The net impact of these factors is unclear.

Non-neutral inflation has an added impact when its real effects are perceived to be temporary. If a given rate of inflation is expected to be maintained in the future, but its real effects are expected to diminish (as, say, the tax system is indexed), life cycle consumers can be expected to save or dissave to spread the impact of the temporary nonneutrality over their lifetime.

In addition to the effects listed above, unexpected inflation generates a redistribution of wealth between creditors and debtors. The impact of this redistribution depends on differences in the behavior of the gainers and the losers. Since the corporate sector is owned by the household sector, the two sectors are aggregated in this analysis. Thus redistributions between households and corporations have no effects by assumption. Transfers between the private sector and the government should be reflected in changes in the government deficit (given government expenditures). Since the deficit appears explicity in this formulation, this effect of unanticipated inflation should be accounted for. The foreign sector remains unaccounted for but, since it is relatively small, transfers between it and the rest of the economy are unlikely to have a large influence on private saving.

Deaton [1977] has suggested that, in addition to the redistribution effects, unexpected inflation may influence saving because it is confused by consumers with relative price changes. If inflation is unexpectedly high, according to this story, consumers mistakenly interpret price changes as relative price increases, and reduce their consumption. Deaton concludes that evidence from the United States supports this hypothesis. Koskela and Viren [1982] find other supporting evidence in several OECD countries.

This discussion suggests that while actual inflation may affect saving for reasons other than mismeasurement of income, it does not unambiguously sign their direction. Moreover, it appears that the expected and unexpected components may have opposite effects. To complicate matters further, these additional effects arise due to institutional structure which varys both across countries and over time in any single country. These considerations suggest it would be difficult to estimate the other effects of inflation even with detailed knowledge of the structure of an economy. In fact no such knowledge is employed in this study. Yet it is important to try to quantify the other effects of inflation - if it has a consistent impact beside that due to the mismeasurement of income, it may disguise the mismeasurement effect.

For this reason a simple linear inflation term is added to (5) to yield:

$$(6) \qquad s = s^*(1 - \lambda\pi^e G/Y) + \delta D/Y + \lambda(1-\delta)\pi^e G/Y + \phi\pi ,$$

where π is the actual rate of inflation and ϕ is taken to be a constant. If inflation in fact predominantly reduces income growth, or has temporary non-neutralities which reduce the income of consumers, ϕ should be negative. If, on the other hand, the capital stock and labor supply rise with inflation, or the unanticipated component induces gives rise to the Deaton effect, ϕ may be positive.

5. The Real Savings Function $s^*(\ )$.

The precise nature of $s^*(\ )$ has been left unspecified in order to focus on the role of government debt and inflation. That goal has been accomplished; in this section I describe a specification of $s^*(\ )$ based on the life cycle hypothesis. Two features account for the aggregate savings rate under the LCH - the asset to income ratio and the rate of growth of income.

Early work on the LCH by Modigliani and Brumberg emphasized the role of income growth in the determination of equilibrium aggregate saving.(2) Further work by Tobin [1967] and Modigliani [1966, 1970, and 1975] explored the relationship in more detail. The link depends

on the observation that individuals generally choose to retire and consume their accumulated wealth, and that the retirement wealth must be accumulated during the working years. Growth in income then tends to (but need not neccessarily) increase the proportion of savers, or those with higher desired retirement wealth, relative to the dissavers. Aggregate savings thus rise. Only if the consumption of the young (those below working age) is high relative to the saving of those of working age will the positive association between growth and saving be broken. There should be no net saving in the absence of income growth in any case, since the aggregate stock of wealth demanded by life cycle savers is constant in that case.(3)

Modigliani [1970], Modigliani and Sterling [1982], Leff [1969] and Ram [1982] have investigated the relative contribution of the two sources of income growth, namely population and productivity growth. This breakdown is not relevant to the issues discussed here, so only total income growth will be considered.

Feldstein has emphasized the role of social security and differences in retirement behavior in determining the desired stock of wealth upon retirement.(4) It is generally true that longer retirement should be accompanied by higher rates of saving (for any given rate of growth of income). This is because longer retirement requires that a greater stock of wealth be accumulated while working, which tends to magnify the impact of growth.

Social security has two effects in Feldstein's analysis; it tends to reduce private saving by replacing private wealth accumulation, and it induces earlier retirement, which tends to increase private saving. While Feldstein and others have generally found the net effect of social security is to reduce private saving, its impact is theoretically ambiguous and difficult to verify empirically.[5]

This discussion suggests that the private savings ratio should be a function of income growth, length of retirement and social security benefits. The function should conform to the implication that the savings rate be zero in the absence of income growth, and that the response of saving to income growth should depend on retirement and social security. A specification which fits these requirements is:

$$(7) \qquad s^*(\ ) = g^*(\alpha_0 + \alpha_1 B + \alpha_2 R),$$

where B is the social security benefit to income ratio, R measures the length of retirement, g the rate of growth of real income, and the α's coefficients.[6] According to the LCH, α_0 and α_2 should be positive, while α_1 should lie between -1 and 0. Substituting from (7) into (6) yields the complete equation:

$$(8) \quad s = g^*(\alpha_0 + \alpha_1 B + \alpha_2 R)(1 - \lambda\pi^e G/y) + \delta D/Y + \lambda(1 - \delta)\pi^e G/Y + \quad .$$

III. ESTIMATING THE PARAMETERS

1. The Approach

In the next section the parameters α_i, ϕ, λ, and δ of equation (8) are treated as coefficients to be estimated using observations of aggregate saving and other data. Before doing so, however, it must be recognized that coefficients estimated using equations of the form (8) are vulnerable to two important criticisms. The first is that observations on realizations of the relevant variables do not reflect the expectations of agents who make the saving decision. The second is that the parameters themselves are implicit functions reflecting the parameters and structure of a larger model. This second criticism implies that, if agents are aware of the structure of the model, their responses to policy changes will induce changes in the values of the parameters. Finally, the source of the error term must be carefully specified.

The second criticism, originating with Lucas [1973] with regard to monetary policy, is relevant to the extent that the estimated coefficients differ from the values implied by theory. In the case of anticipated capital losses, government deficits, social security and income growth the analysis assumes that agents are completely aware of their budget constraints. If agents are aware of their budget constraints and the estimated coefficients are different from their predicted values, it is an indication that there are components of the budget constraint that are not adequately modeled. In that

case, since sources of the failure of the model are not well understood, policies which attempt to expoit the coefficients may have unexpected implications. In the case of changes in saving due to inflation alone (not the capital losses it may imply) the estimated coefficient is likely to unstable. This is because any large impact of inflation is likely to be due to nominal institutions which will adjust to continued inflation.

The first criticism, that realizations do not reflect expectations, is likely to be more of a problem. All of the variables on the right hand side of (8) exhibit cyclic and other temporary fluctuations which are presumably not relevant for the life cycle planning models assumed here. The approach taken here is to take long, nonoverlapping averages of annual data to represent the outcomes relevant to the life cycle planning decisions. While this is costly in terms of information lost in the averages, it is certainly more likely to reveal the relevant secular trends than using each anual observation.

2. The Error Term

There are two sources of error in equation (8). The variables may be measured with error and the specification, particularly the real life cycle component $s^*(\ )$ may be specified incorrectly. I will ignore the general errors in variables problems which arise if the explanatory variables are measured with error, except for the component associated with $s^*(\ )$. Errors associated with $s^*(\ )$ cause

particular problems because of the nonlinear nature of the model.

The measured LCH savings function, $s^*(\ )$ postulated in section I.5, is only an approximaton to the true function $s^{**}(\ )$. Suppose that the approximation introduces an error term ε_i, so that $s^{**} = s^* + \varepsilon_i$, and the true savings ratio equation (8) is given by:

$$(9) \quad s_i = (s_i^* + \varepsilon_i)(1 - \lambda CL_i) + \delta DEF_i + \phi\pi_i + \lambda(1 - \delta)CL_i + \eta_i,$$

where η_i is the residual arising from measurement error in s_i. (The notation has also been changed for simplicity: CL refers to the capital loss to income ratio and DEF the government deficit to income ratio.) Combining the errors into a single term ζ_i, the sum of the residuals associated with (9) is given by:

$$(10) \qquad \zeta_i = \varepsilon_i(1 - \lambda CL_i) + \eta_i.$$

From (10) it can be seen that the residual ζ_i will be negatively correlated with the capital loss variable, as long as λ has a postive sign. This is likely to produce estimates of λ which are negatively biased.[12]

Two stage least squares is the natural technique to use in this situation. However, not all the other explanatory variables can be considered exogenous - both the government deficit and the rate of

inflation are likely to respond to aggregate demand and saving. The length of retirement is also endogenous, but forms a recursive system with the savings ratio equation and so may be treated as exogenous (as long as the residuals of the retirement and savings ratio equations can be taken to be independent). The remainng variables, real income growth and the social security replacement rate are taken to be exogenous. Though they may reflect some simultaneous interaction with income and saving, it is likely to be small. The instruments used are: a unit vector, demographic variables reflecting the age compostion of the labor force, and the rate of change of claims against the government held by the central bank.

A further complication is arises from the likely correlation of the error associated with each country over time. This corresponds to the problem of autocorrelation arising in time-series contexts. An estimation technique which takes this correlation into account will yield more efficient estimates. Three stage least squares is the appropriate technique in this case, as it exploits the information available in the correlation across residuals as well as replacing the endogenous variables by their two-stage projection.(13)

IV. THE DATA

Data from an international cross-section of 20 OECD countries is used to estimate the parameters of the aggregate savings function.(7) The data is collected within a standardized system of national accounts, which should yield at least broad international comparability. It is

generally available for the period 1960 - 1979.

Income, saving, and price (CPI) data are from the OECD [1982]. Private savings include both household and corporate savings, calculated on an expenditure basis. Disposable income is defined to be the sum of consumption expenditures and private saving. The measured private savings ratio is simply the ratio of private saving to disposable income. While this is a measure of gross saving rather than the more appropriate net of depreciation measure, there is no standard way of adjusting international data for depreciation. Similarly, computing saving on an expenditure basis is the only feasible approach with the available data. Work by Blades and Sturm [1982] indicates that the international rank ordering is at least preserved by sensible adjustments for purchases of durable goods. However, Hayashi's [1982] recent estimates for the United States indicate that the distinction between consumption flows and expenditures may be an important one.

The annual rate of growth of real income is calculated by taking natural logs of the ratio of current to lagged real disposable income.

The government deficit data is from the same OECD source, and is defined to be the difference between government expenditures on the current account and its receipts. This includes the current account saving of both central and state and local governments as well as public social security programs. It excludes government expenditures

on the capital account, since they are unlikely to represent a future tax burden.

Government debt data is from the International Monetary Fund [1982] whenever available, though for some countries the debt data was gathered from national sources.(9) The appropriate measure of the public debt for our purposes is general government debt (net of debt held by the government) held domestically. Often, however, only central government debt was available, and it was often impossible to calculate the fraction held by the private sector. These omissions introduce biases which appear to be small and offsetting.(10) The actual capital loss is measured by taking the ratio of the product of the actual rate of inflation and the public debt to nominal income; the expected rate is taken to be the average of the actual loss.

Estimates of the social security benefits and the length of retirement are based on the work of Modigliani and Sterling. The social security benefit data is taken from the ILO's publication The Cost of Social Security (various issues) and is a measure of aggregate pension benefits. To estimate the benefits per recipient relative to income per worker, the aggregate pension to income ratio is divided by the ratio of nonworking males above 65 to active males. This population ratio is chosen to represent as closely as possible the number of social security recipients relative to those expecting benefits; data based on those concepts is unavailable. Haanes-Olsen [1978] has made more detailed estimates of the social security replacement rate for twelve countries. These estimates suffer from

several drawbacks. Most importantly they measure the replacement ratio for workers in manufacturing only. They do, however, provide an alternative source for comparison.[11]

The retirement variable is the ratio of the change in labor force participation rates between those in the 50-54 and 65+ age groups, relative to the participation rate of those in the 50-54 age group. The participation rates are those for both men and women, and are taken from the Yearbook of Labor Statistics, published by the ILO. This measure is based on the techniques used in the analysis of retirement age in the United States by Reimers [1976]; it represents an adjustment to the life expectancy at retirement (which is assumed constant across countries) to reflect the fact that not all people retire at 65. An increase in R signifies an increase in the duration of retirement.

Summary statistics for the data used in this study are presented in the tables below. Table 1 shows the means and standard deviations, tables 2A, 2B and 2C show various correlations, and in table 3 the correlations between the capital loss variable and its components are examined in detail.

Table 1. Means and Standard Deviations of the Data.

Variable*	Period 1 (1960-69) mean	Period 1 (1960-69) standard deviation	Period 2 (1970-79) mean	Period 2 (1970-79) standard deviation
s	0.144	0.039	0.158	0.045
g	0.053	0.018	0.039	0.012
B(H)	0.492	0.100	0.558	0.100
B(I)	0.382	0.157	0.480	0.188
R	0.735	0.123	0.833	0.102
CL	0.013	0.011	0.031	0.032
π	0.037	0.011	0.094	0.031
DEF	-0.056	0.038	-0.043	0.050

(*)The variables are defined in the text. B(H) is the social security replacement ratio measured by Haanes-Olsen for 12 countries, B(I) is the rate based on ILO data for all 20 countries, CL is the capital loss variable and DEF is the current account government deficit.

Table 2A. Correlations Among the Variables in the First Period

	s	g	B(I)	R	CL	π	DEF
s	1						
g	0.45	1					
B(I)	-0.06	-0.05	1				
R	-0.10	-0.48	0.62	1			
CL	-0.23	-0.45	-0.11	-0.02	1		
π					0.11	1	
DEF	0.10	0.23	-0.44	-0.26	0.45		1

Table 2B. Correlations Among the Variables in the Second Period.

	s	g	B(I)	R	CL	π	DEF
s	1						
g	0.35						
B(I)	-0.34	-0.42	1				
R	-0.39	-0.47	0.50	1			
CL	0.04	-0.11	-0.04	-0.12	1		
π					0.31	1	
DEF	0.49	0.40	-0.35	-0.24	0.52		1

Table 2C. Correlations Among the Variables Between Periods.

	Variable						
	s	g	B(I)	R	CL	π	DEF
Correl.	0.81	0.49	0.89	0.94	0.87	0.23	0.91

Table 3. Correlations Among CL and its Components.

Period 1

	CL	π	DEF
CL	1		
π	0.31	1	
DEF	0.94	-0.14	1

Period 2

	CL	π	DEF
CL	1		
π	0.46	1	
DEF	0.94	0.22	1

The summary tables reveal a familiar story. Real income growth declined, on the average, by more than 25 percent between the sixties and the seventies; inflation more than doubled, as did the capital losses (relative to income) suffered by the private sector. Both the social security replacement rate (however measured) and retirement rose considerably. Government deficits on the current account as a fraction of income fell noticeably. The negative entry for government deficits reflects the fact that, on the average, the general government sector was a net saver.

The savings ratio increased on the average between the two periods, contrary to popular perception.

The summary table conceals one remarkable observation. Japan, whose 22 percent savings ratio matched its 9.5 percent income growth rate in the sixties, experienced a dramatic drop in its rate of growth of income (which is expected to be permanent), yet slightly increased its savings ratio to 24 percent of disposable income. This appears, at least, to be inexplicable according to the theory developed here.

V. PARAMETER ESTIMATES

Estimates of equation (8) are given in table 4.[14] Two sets of coefficients are reported for each restriction tested. The first set, in the left side of each column, are estimates for the second

period. The second set, in the right side of each column, are estimates for the second period. (Estimates for each period reflect the correlation between the residuals of the two periods in the 3SLS results.) When the coefficients are constrained to be equal in the two periods their common value is given in the center of the column.

In addition to the coefficients and their standard errors, two measures of goodness of fit are presented. The first, in the row labelled "COR", is the correlation between the fitted values using the reported coefficients and the dependant variable. This is just the square root of the R^2 measure appropriate in ordinary least squares regressions; it reported here because the conventional R^2 is unlikely to be meaningful in the nonlinear weighted estimation reported here. The second measure, ln(WSSR), is the weighted sum of squared residuals used as the basis for the chi-square test derived in Gallant and Jorgenson [1979]. The difference between the value of this statistic in the restricted and unrestricted estimates is distributed chi-square with degrees of freedom equal to the number of restrictions.

In all cases the social security variable is a mixture of the ILO and Haanes-Olsen measures discussed above. The two measures have different slopes but are constrained to have the same intercept, a specification similar to that employed by Modigliani and Sterling. The specification was not rejected by the data, and was chosen because it gave somewhat more reasonable parameter estimates than those found using the ILO data alone.

The residual covariance matrix is estimated using the 2SLS residuals from (4.1); the same matrix is used in all the restricted estimates.

In the first column of table 4 (equation (4.1),) equation (8) is estimated over the two periods independently, using nonlinear two-stage least squares. In (4.2) the analogous 3SLS estimates are reported. The efficiency gains due to the 3SLS technique are impressive, averaging a 25 percent reduction in standard errors relative to the 2SLS estimates. This reflects the relatively high correlation between the residuals in the two periods, estimated to be roughly 0.47.

The unrestricted coefficient estimates themselves, however, are disappointingly insignificant. Only α_0 in the second period, and λ and δ in the first period are estimated to be more than twice their standard errors. The shift in the coefficient estimates between the 2SLS and the 3SLS estimates is also surprising though, in view of the large standard errors, is not significant. The changes in the coefficient values also markedly reduces the explanatory power of the equation in the second period, as measured by COR. One reason for this weakness is the large number of parameters estimated. There is little reason to believe that the behavioral parameters shifted between the sixties and the seventies. In (4.3) this restriction is tested by constraining all the coefficients to be equal across the two periods.

The data do not support the restriction that all the coefficients of (8) are equal over time. The chi-square value at the the 99 percent level with 8 degrees of freedom is 22, while the test statistic for specification (4.3) is nearly 25. Apparently there have been significant shifts in coefficient values between the two periods. In fact, imposing all the equality restrictions yields a negative correlation between the fitted values of the savings ratio generated by (4.3) and the actual values in the second period!

This conjecture is supported by the estimates reported in column (4.4). In this case the social security and retirement variables are constrained to be equal in the two periods, while the remaining coefficients are free to vary. This specification is marginally rejected at the 95 percent level, but accepted at the 99 specification shows the greatest number of equality restrictions accepted by the data. The estimates in (4.4) remain somewhat disappointing, however. The social security and retirement variables remain quite weak, and the constant term shifts puzzlingly between the two periods. The explanatory power of the equation in the second period also remains very low.

The capital loss, government deficit and pure inflation coefficients tell a somewhat stronger story. The coefficient on capital losses in the first period is almost precisely unity, though it remains near zero and insignificant in the second period. The government deficits variable shows a similar pattern, but it is large and significantly negative in the first period, contrary to the predictions of the

theory. The pure inflation coefficient, ϕ , changes sign between the two periods and is quite weak in both. This pattern is consistent with the reservations expressed earlier concerning the stability of this coefficient.

The theoretical and empirical weakness of the pure inflation variable suggests that it should be constrained to zero, a specification which is reported in (4.5). The zero restriction on ϕ is not rejected by the data. The test statistic has a value of 10.62, while the chi-square statistic at the 95 percent confidence level with 5 degrees of freedom is 11.07. This suggests that the capital loss effect is the only significant channel through which inflation affects private saving.

The impact of these restrictions is most noticeable on the capital loss coefficients. The first period coefficient falls by 25 percent (as does its standard error), while the second period coefficient rises, and its standard error falls. Both the social security and retirement coefficients rise in magnitude, though they fail to become significant. The restriction has little impact on the government deficit coefficients, which continue to have the wrong sign.

The fact that the capital loss coefficients are much closer suggests that an equality constraint may be appropriate. This restriction is imposed in (4.6). It is rejected at the 95 percent confidence level, but accepted at the 99 percent level. The capital loss coefficient drops to 0.58 with a standard error of 0.20.

Two polar cases are tested in equations (4.7) and (4.8). In (4.7) the capital loss coefficient is constrained to be unity, the value predicted by theory. This restriction is rejected at the 95 percent level, but barely accepted at the 99 percent level. In (4.8) the capital loss coefficient is constrained to be zero. This restriction, in combination with the zero restriction on the other effects of inflation, implies that inflation has no impact on private saving. It is rejected at the 99 percent confidence level. The explanatory power of the equation also falls steeply in both periods.

2. Discussion

The results presented in table 4 reveal a consistent, if somewhat puzzling pattern. The major puzzle revealed is the inability of the version of the LCH analyzed here to account for the upwards shift in private savings ratios between the sixties and the seventies. The shift appears as an unexplained but significant shift in the constant term in all the equations reported in table 4. This analysis is also unable to explain as much of the variation in the saving ratio in the seventies as in the sixties. This may reflect greater turbulence in the world economy during the seventies, suggesting that short run forces played a greater role in that period than in the sixties. Furthermore, the standard life cycle variables - social security and retirement - have weak coefficients. As shown in (4.8), however, this is consistent with earlier findings of strong effects in studies in which the impact of capital losses was neglected. If this channel is explicitly accounted for, however, the social security and life

cycle variables appear to have only a weak influence.

Capital losses have the expected saving-inducing effect. The effect, however, is not complete (it is estimated to be 0.58 when the effect is constrained to be equal in the two periods), and is much stronger in the 1960-69 period than the 1970-79 period. This is surprising, as the capital losses were a much higher proportion of income in the second period. The weaker effect observed in the seventies may be explained by persistent underestimation of inflation. If inflation is underestimated capital losses are underestimated and income is overestimated; these phenomena tend to reduce saving and the coefficient on average actual capital losses. Underestimation of inflation is also consistent with the negative <u>ex-post</u> real rates of interest widely observed in the seventies.

The saving-inducing affect of inflation induced capital losses is consistent with the estimates of the impact of government deficits. Private saving does not increase with government deficits, indicating that people do not anticipate paying taxes on the debt in the future. In fact, private saving appears to be negatively correlated with deficits in the first period. This is not consistent with the prediction of the LCH that at least a fraction of the value of government bonds must be paid off in future taxes. While the importance of anticipated taxes has been empirically verified by only a few authors, the lack of support for a role of future of future taxes found here is startling.[(15)]. Though this result is consistent with a negative correlation induced by countercyclical policy, that

spurious correlation should have been eliminated in the two-stage procedure. Once again this effect is significantly weaker in the seventies.

Finally, the data cannot reject the hypothesis that inflation has no consistent effect on private saving other than through the capital loss channel. These other effects are likely to arise largely due to nominal institutions which should adjust to continued inflation. Apparently there is so much institutional variation across countries and time that the other effects cannot be discerned in this sample.

These observations are not unduly influenced by the Japanese observation. The estimates obtained when Japan is excluded are similar to those shown in table 4, except that the upwards shift in the constant term is insignificant, and the social security and retirement terms are much stronger. The negative correlation between government deficits and private saving in the first period is also much stronger.

V. CONCLUSIONS

The results reported in this paper support the following conclusions:

+ Anticipated capital losses on nominal assets induce compensating increases in saving, though not by the full amount predicted by the life cycle hypothesis.

+ Contrary to predictions of the life cycle theory, government deficits do not appear to be associated with increased private saving. There is evidence that government deficits were associated with reduced private saving in the sixties.

+ Inflation has no consistent affect on private saving other than via the capital losses on nominal outside debt.

+ The relationship between life cycle variables and private saving is somewhat unstable. There is no theoretical justification for the magnitude of the upward shift in the savings rate in the seventies. However, the significance of the shift is largely due to the Japanese observation.

+ Estimates of the effect of social security and retirement are highly correlated with estimates of the impact of inflation induced capital losses. If these losses are neglected, social security and retirement appear to be stronger determinants of private saving than if the losses are correctly accounted for.

FOOTNOTES

1) Christ [1957], in a review of the first edition of Patinkin's book, attributes the recognition that government deficits imply increased future taxes to discussions with Milton Friedman.

2) The Modigliani-Brumberg piece referred to here was written in 19 , but not published until 1979.

3) See Appendix A for a more detailed derivation of these results.

4) Initially in Feldstein [1974]. Feldstein has estimated the impact of social security in international cross-section in [1977] and most recently in [1980]. Feldstein's time-series analysis for the United States has been more controversial; see Leimer and Lesnoy [1982] and the references cited there, as well as Feldstein's response [1982].

5) See Modigliani and Sterling [1982] for a demonstration of the empirical difficulties with cross-section estimates, and Leimer and Lesnoy for difficulties with the US time series.

6) The specification (7) is slightly different from that used in Modigliani and Sterling. This is because income growth was decomposed into its productivity growth and labor force growth components in that paper, and the length of retirement entered in the growth of the labor force terms.

7) See Appendix B for the data.

8) The income and saving date for Denmark are an exception. Recent data for Denmark are unavailable from the OECD, and an examination of the Danish statistical yearbook revealed large differences from the OECD's exstimates. Since the Danish debt data are taken from Danish sources, I decided to use the Danish Statistical Yearbook throughout.

9) Data from national sources was used for: Denmark, the United Kingdom, and the United States. For Denmark and the United Kingdom their statistical yearbooks are the source; for the United States the Federal Reserve Flow of Funds Accounts were used.

10) In all cases for which a comparison could be made (Japan, the United Kingdom and the United States) the IMF estimates were quite close to that obtained in more detailed examination of national sources.

11) See Modigliani and Sterling for a comprehensive discussion of the various possible measures of social security benefits.

12) The appearence of CL_i in the error term may also introduce heteroskedasticity; this potential source of inefficiency is ignored.

13) See Theil [1971, sec. 10.6] or Kmenta [1971, sec. 13-4]. The equations are also weighted by the square root of their population in each period to correct for heteroskedasticity introduced by population size differences.

14) Table 4 appears at the end of the paper.

15) Kochin [1974] and Barro [1978] are the only two studies with which I am familiar that have claimed to test directly the role of government deficits in inducing private saving and found confirming evidence. However, see Buiter and Tobin [1979] and Feldstein [1978] respectively for a critical analysis of articles.

APPENDIX A

A simple way to determine the implications of the LCH for aggregate saving behavior is to sum across individuals to obtain aggregate income and consumption, and subtract to obtain aggregate savings, which can then be related to characteristics of the individual's consumption function.

Aggregation proceeds particularly simply in a world in which population and productivity growth (defined to be growth in per capita income are exponential trends. Let $y(a,t-a)$ denote per capita labor income of an individual aged a at time t, and $m(a)$ the mortality function, describing the probability of surviving until year t. The number of people of age a at time t, $n(a,t)$, is then given by $m(a)B(t-a)$. The exponential growth assumptions imply that $y(a,t-a)$ and $n(a,t-a)$ may be written:

(A1a) $$y(a,t-a) = y(a)e^{g(t-a)}$$

(A1b) $$n(a,t) = m(a)B(0)e^{p(t-a)},$$

where g and p are the rates of growth of productivity and the labor force respectively. (Note: g represents total real income growth in the body of the paper.) In assuming productivity and population growth of this type, I take the age profile of earnings and mortality to be constant over time, while productivity gains are strictly embodied.

Aggregate income at time t, $Y(t)$, is the sum of the earnings of all those employed at time t, plus interest on the stock of wealth at t. Assuming that all individuals begin work at age w and retire at age r, and letting ρ be the (fixed) real rate of interest and $W(t)$ the aggregate stock of wealth at t, aggregate income is given by:

(A2) $$Y(t) = n(a,t)y(t-a)da + \rho W(t)$$

$$= e^{(g+p)t}\, m(a)y(a)e^{-(g+p)a}da + \rho W(t),$$

where $B(0)$ is taken to be unity without loss of generality.

In order to determine $W(t)$ we proceed as above by summing across individual's to obtain aggregate wealth. An individual's net wealth at age a, $w'(a,t-a)$, is given by the sum of his or her net saving at each age, discounted to reflect interest charges and earnings. Letting $c(a,t-a)$ denote an individual's consumption of age a at time t, and assuming people are born and begin consuming at age 0 and do not survive beyond age 1, $w'(a,t-a)$ is given by:

$$(A3 \qquad w'(a,t-a) = [y(x,t-a) - c(x,t-a)]e^{\rho x}dx$$

Under the LCH individual's are assumed to solve the utility maximization problem subject to their lifetime budget constraint:

$$(A4) \qquad \max \quad U(c(x))m(x)e^{-\rho x}dx$$

$$\text{s.t.} \quad m(x)c(x,t-a)e^{-\rho x}dx = e^{g(t-a)}\, m(x)y(x)e^{-\rho x}dx,$$

assuming for simplicity that the individual's rate of time preference equals the interest rate. Given the additional assumption that tastes are constant over time, each succeeding generation will choose the same stream of consumption, up to a proportionality factor reflecting per capita income growth at the rate g. Thus the wealth of an individual of age a of cohort $t-a$ is given by:

$$(A5) \qquad w'(a,t-a) = e^{g(t-a)}\,(y(x) - c^*(x, \;))e^{\rho x}dx,$$

where $c^*(x,\rho)$ represents the solution to (a4).

Tobin [1967] solved the maximization problem (A4) for a specific utility function and under different assumptions to yield an explicit expression for $w'(a,t-a)$.

The aggregate stock of wealth is given by the sum over all individuals at time t:

$$W(t) = n(a,t-a)w'(a,t-a)da,$$

or:

$$(A3) \qquad W(t) = e^{(g+p)t}\, m(a)e^{-(g+p)a}[y(x) - c^*(x,\rho)]e^{\rho x}dxda.$$

The double integral in (3) is independant of time, implying that the aggregate stock of wealth must grow at the same rate as aggregate income, so that a constant wealth to income ratio is maintained.

In the absence of capital gains, saving is given by the time derivative of wealth. Differentiating $W(t)$ with respect to t, and dividing by income to yield the savings ratio, s, yields:

$$\text{(A7)} \qquad s = (g+p)W/Y$$

Equation (A7) expresses the basic result reported in the text, that the savings ratio increases with the rate of growth of real income. However, the wealth to income ratio is also a function of the rate of growth of income. It is this dependancy which makes the link between real income growth and saving ambiguous at high rates of growth of income. While the derivative of W/Y is likely to be small, its sign is ambiguous. If income growth and consumption while young are sufficiently high, the wealth to income ratio may fall as $g + p$ rises.

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Table 4. Estimates of the Parameters of the Savings Ratio Equation *

$$s = (\alpha_0 + \alpha_1 B + \alpha_2 R)(1 - \lambda CL) + \delta DEF + \phi\pi + \lambda(1 - \delta)CL$$

Coef.	(4.1)		(4.2)		(4.3)		(4.4)	
α_0	0.71 (1.25)	4.60 (2.25)	1.49 (0.97)	5.40 (1.76)	0.25 (0.72)		1.64 (0.96)	2.69 (1.03)
α_1(H)	-0.64 (1.12)	-2.52 (2.46)	-0.24 (0.86)	-1.09 (1.88)	-0.11 (0.79)		0.12 (0.85)	
α_1(I)	-2.50 (1.51)	-3.36 (3.15)	-2.03 (1.18)	-2.43 (2.44)	-1.38 (1.11)		-1.36 (1.15)	
α_2	2.39 (2.11)	0.47 (4.22)	1.18 (1.61)	-1.99 (3.22)	1.99 (1.41)		0.71 (1.59)	
λ	0.55 (0.42)	0.38 (0.77)	0.95 (0.31)	0.29 (0.49)	0.27 (0.20)		1.01 (0.30)	0.03 (0.37)
δ	-0.71 (0.20)	0.10 (0.34)	-0.71 (0.15)	-0.03 (0.27)	-0.61 (0.12)		-0.75 (0.15)	-0.20 (0.24)
ϕ	-0.32 (0.92)	0.03 (0.57)	-0.65 (0.70)	0.26 (0.43)	0.73 (0.15)		-0.71 (0.69)	0.33 (0.38)
COR	0.47	0.44	0.48	0.38	0.43	-0.37	0.43	0.19
ln(WSSR)			32.52		57.39		40.71	

*)Standard errors in parentheses. See text for explanation of variables.

Table 4. Estimates of the Parameters of the Savings Ratio Equation (continued)

$$s = (\alpha_0 + \alpha_1 B + \alpha_2 R)(1 - \lambda CL) + \delta DEF + \phi\pi + \lambda(1 - \delta)CL$$

COEF.	(4.5)		(4.6)		(4.7)		(4.8)	
α_0	0.85 (0.77)	2.69 (0.87)	0.52 (0.76)	2.09 (0.87)	0.84 (0.73)	2.44 (0.82)	-0.06 (0.72)	1.69 (0.79)
α_1(H)	-0.23 (0.81)		-0.39 (0.81)		-0.28 (0.81)		-0.80 (0.79)	
α_1(I)	-1.74 (1.11)		-1.82 (1.12)		-1.69 (1.11)		-2.36 (1.09)	
α_2	1.58 (1.49)		2.15 (1.46)		1.63 (1.42)		3.38 (1.38)	
λ	0.77 (0.23)	0.24 (0.26)	0.58 (0.20)		1.00		0.00	
δ	-0.68 (0.13)	-0.24 (0.24)	-0.72 (0.12)	-0.19 (0.24)	-0.59 (0.11)	0.05 (0.22)	-0.77 (0.12)	-0.21 (0.22)
ϕ	0.00		0.00		0.00		0.00	
COR	0.44	0.19	0.42	0.19	0.47	0.28	0.39	0.16
ln(WSSR)	43.14		47.14		50.72		56.75	